Grower Summary

Development and implementation of season long control strategies for *Drosophila suzukii* in soft and tree fruit

SF/TF 145a

Final report 2021

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DISCLAIMER

[The results and conclusions in this report are based on an investigation conducted over a one-year period. The conditions under which the experiments were carried out and the results have been reported in detail and with accuracy. However, because of the biological nature of the work it must be borne in mind that different circumstances and conditions could produce different results. Therefore, care must be taken with interpretation of the results, especially if they are used as the basis for commercial product recommendations.]

GROWER SUMMARY

Objective 1. Continued National Monitoring of the populations of D. suzukii in Scotland and England

Task 1.1. National Monitoring in England and Scotland (NIAB, JHI, NRI)

Headline

- *D. suzukii* numbers at NIAB EMR in 2021 overall, were similar to the catch numbers of 2015 and 2016 (Jan-Oct). 2021 did not express an activity trend closely associating to any other years until late July; 2017 (from Jul-Oct) and 2020 (Jul-Aug, and Nov).
- As with previous years at NIAB EMR, unprecedented peaks in trap catches occurred in conjunction with uncharacteristic peaks in temperature.
- *D. suzukii* numbers in Scotland in 2021 were higher than previous years.

Background and expected deliverables

Since the first detection of *D. suzukii* in the UK in 2012, populations of the pest have continued to rise in most regions of England. In contrast, populations in Scotland, in which the pest was first detected in 2014, have been slow to increase. To monitor the pest, modified Biobest traps using the Char Landolt bait system were deployed in a range of commercial and wild crops in 2013 at 14 sites across the UK.

In collaboration with Berry Gardens, in 2017 and 2018, the main fruit growing regions of England were monitored by 57 traps across 9 farms (Kent, Surrey, Herefordshire, Staffordshire, Northamptonshire, Yorkshire and Norfolk) and 40 traps on 4 farms in Scotland.

In 2019, monitoring was reduced to maintaining 10 traps in England at NIAB EMR and 3 traps in Scotland at JHI, both including one wild area. Monitoring data is summarized monthly from both institutes and reported to the project team at project meetings and is disseminated to growers and other stakeholders at regular intervals. Although there is a reduction in the number of monitoring traps, NIAB EMR and JHI were still able to provide the AHDB with updates on pest dynamics which in turn are used to alert growers to key SWD population events.

Predictive models have been developed using historic trap catch data collected within this objective coupled with environmental information. The models have been successful in predicting first spring female peak (93.3% accuracy), SWD presence / absence (90.2%

accuracy), first summer peak (83.1% accuracy), and female fecundity (76.1% accuracy). Modelling can also predict female activity based on male activity (83-87% accuracy) and time required to reach a % value of SWD population size (72-99% accuracy). These weather-dependent predictive tools could be further improved with the addition of more SWD data, in particular fecundity.

Summary of the project and main conclusions

At NIAB EMR, the activity-density of adult *D. suzukii* in the monitoring traps was lower in the spring (March - May) 2021 (Figure 1.1.1 pink line) compared to 2019 and 2020. This was likely caused by a prolonged cold winter and spring. Numbers of *D. suzukii* caught in the traps were lowest during the period of peak fruit production and in 2021 which is consistent with previous years. In July, 2021's trap catch trend more closely followed 2020's and 2017's (Figure 1.1.1 red line) until mid-August, and continuing from then, 2021 only continues to follow 2017's trend through to the midst of autumn (mid-October), where it has sharply risen in November.

In Scotland, average peak trap catches have varied between years, and are typically 10-40-fold lower than numbers collected at NIAB EMR. The pattern of abundance is similar between years, with insects appearing in traps in August-September, increasing to a peak in October-November, then decreasing to low values December-January. Winter/spring catches are low with very few insects trapped. Highest peak catches were obtained in 2021(*c.* 35 per trap). There is an indication that trap catches at the Hutton site might be increasing in 2019-2021 compared with earlier years. However, this may be a local finding.

For both Scotland and England, there continues to be a general year-on-year increase in annual mean trap catch, except for the year 2020 where a decrease of ~14 SWD per trap was recorded at JHI compared to 2019. At NIAB EMR trap catches rose year-on-year until 2019.

Data has been collated throughout the reporting period and regularly sent to AHDB.

Action points for growers

- Be aware of AHDB communications with alerts to key SWD monitoring events.
- Continue to monitor adult SWD in hedgerow and cropping areas.
- Monitor for adult *D. suzukii* presence and fruit damage throughout the season, particularly in Sept/Oct when abundance is highest

Objective 2. Develop and optimise a push-pull system using repellents, and attract and kill strategies

Task 2.1. Evaluating the efficacy of repellents to protect cherry and raspberry fruit from SWD oviposition. (NIAB & NRI)

Headline

- Repellent 129/08, formulated in slow-release dispensers, has been shown previously to reduce emergence in polytunnels.
- The same formulation was tested for efficacy against *D. suzukii* in a strategic cherry orchard and a commercial raspberry crop in a replicated field trial in 2021
- There was no significant difference between numbers of *D. suzukii* emerging from treated and control fruit at any time point in either crop.

Background and expected deliverables

Push–pull is a strategy for controlling agricultural pests, typically using a repellent plant to "push" the pest out of the target crop towards an attractant acting as the "pull". Work conducted by NIAB EMR and NRI CTP student, Christina Conroy, led to identification of several compounds which might repel *D. suzukii*. Two of the compounds tested reduced numbers of larval *D. suzukii* emerging from fruit at distances of over 6 m in polytunnels. The objective of the trials described below was to test one of these repellents, coded 129/08, in open field trials. If effective, the expected deliverable from this work would be a repellent formulation that could be incorporated into a push-pull system, alongside existing attractants, to reduce damage by *D. suzukii* in commercial crops.

Summary of the project and main conclusions

The repellent that was most effective over the largest distance in Christina Conroy's work (129/08) was taken forward to tests efficacy within a strategic cherry orchard and a commercial raspberry crop. Dispensers were deployed within blocks of cherry trees or raspberry canes at flowering, a minimum of 1 month prior to first fruit assessment. For cherry, the first assessment was taken at white fruit stage and for raspberry at 1st commercial pick. Fruit samples were collected from the central area of treated and untreated blocks, where no 129/08 dispensers were deployed. The number of larvae were extracted using the sugar water method and larval counts compared between treated and untreated blocks.

For the cherry trial, there was an interaction between assessment number and treatment on number of larvae recovered. However, there was no significant difference at any assessment in either crop.

An effective repellent has been identified in small-scale field trials, but this needs to be optimised before it can be implemented in commercial crops. Additional work is required to confirm correct densities of deployment, release rates and timing of deployment. The efficacy of the repellent in combination with an effective ‘pull’ device, such as a trap, should also be a priority for investigation.

Action points for growers

There are no actions at this point.

Task 2.2. Investigating the potential of precision monitoring to reduce fruit damage in the neighbouring crop by reducing numbers of overwintering D. suzukii (NIAB).

Headline

- From September 2019 to March 2022 we investigated whether implementation of precision monitoring in winter refuges can reduce the winter form of *D. suzukii* and numbers migrating into the neighbouring soft fruit crop during the subsequent cropping season.
- Sentinel fruit traps were deployed spring 2020 and 2021 of the trial and showed some evidence to suggest precision monitoring can reduce the incidence of *D. suzukii* egg laying in the neighbouring soft fruit crop.
- Data also showed where there was precision monitoring (both woodlands and neighbouring soft fruit crops), fewer *D. suzukii* were caught in RIGA monitoring traps compared to untreated (control) equivalents most assessments during the two and a half year trial. However this difference was only statistically significant when catches of female *D. suzukii* were analysed and only on 4 assessments out of the 41 made.
- Analysis of precision monitoring trap position in 2020 found traps positioned on the woodland perimeter nearest the crop caught significantly more male *D. suzukii* than within the main woodland during summer, autumn and winter.
- We found evidence to suggest the more favourable vegetation surrounding traps is to *D. suzukii* and the more coverage, the more *D. suzukii* were caught.
- Bramble and ivy were the only species found to have a significant positive influence on catches of *D. suzukii*, during summer and autumn assessments respectively.

Background and expected deliverables

Alongside commercially grown fruit, *D. suzukii* utilises wild fruits and habitat where it can find food and a shelter year-round (Grassi et al, 2011). Such habitats provide a source of *D. suzukii* at the beginning (winter form) and throughout the crop growing season (summer form), which migrate into crops. This is supported by the institute monitoring (Objective 1), which shows high activity peaks of *D. suzukii* in woodlands at NIAB EMR during late autumn/early-winter when there is reduced availability of commercial and wild fruit.

From October 2019 to March 2020 we investigated whether implementation of precision monitoring in winter refuges can reduce the winter form of *D. suzukii* and numbers migrating into the neighbouring soft fruit crop during the subsequent cropping season.

The main aims were to determine whether:

- Precision monitoring for the *D. suzukii* winter morph can reduce the incidence of fruit damage in the neighbouring crop in spring.
- Continued precision monitoring in woodland winter refuge habitat during the growing season can maintain protection against *D. suzukii* fruit damage in the neighbouring crop.
- Traps can be positioned more strategically to optimise catches of *D. suzukii.*

Summary of the project and main conclusions

In October 2019, a grid of 64 precision monitoring traps, spaced at 8 metre intervals, were deployed in a small isolated pocket of woodland on 6 soft fruit farms in Southeast England. Also on each farm, a second similar sized pocket of woodland with no precision monitoring traps, serving as an untreated control was assessed. A commercial RIGA monitoring trap was deployed in each woodland and respective neighbouring crop to monitor and compare *D. suzukii* population numbers throughout the trial. In addition, sentinel fruit was deployed in spring 2020 and 2021 to monitor *D. suzukii* egg laying. The trial also investigated whether precision monitoring traps can be positioned more strategically according to surrounding host vegetation and abiotic factors, to optimise *D. suzukii* catches, hence establishing a more targeted approach which would reduce labour in the maintenance of the traps.

Sentinel fruit deployments showed some evidence to suggest precision monitoring for the *D. suzukii* winter morph can reduce the incidence of fruit damage in the neighbouring crop. For 6 out of the 8 sentinel fruit deployments (April to June 2020 and 2021 combined) fewer *D. suzukii* were counted emerging from fruit deployed in treated woodlands and neighbouring soft fruit crops compared to untreated (control) equivalents. However, this difference was only statistically significant on 2 occasions. *D. suzukii* numbers emerging from fruit was low in general, probably due to competition from other Drosophila spp. which emerged from the same fruit in much higher numbers both years.

Overall fewer male and female *D. suzukii* were caught in monitoring traps in woodlands treated with precision monitoring and their neighbouring soft fruit crops compared to untreated equivalents, but the difference was inconclusive. Approximately half the number of adult *D. suzukii* (males and females) and adult female *D. suzukii* were caught by RIGA monitoring traps in treated woodlands and neighbouring crops compared to control equivalents, however this difference was not statistically significant. For 31 out of the 41 trap counts made at regular intervals during the trial, fewer adult *D. suzukii* were caught in treated crops compared to control crops, but the differences were not statistically significant. The difference was only statistically significant for catches of female *D. suzukii* at 4 trap counts, each made late-winter/early-spring (2020 and 2021). Between June and October 2021, fewer adult *D. suzukii* were caught in treated crops compared to control equivalents 5 out of the 6 assessments. During the same period in 2020, fewer adult *D. suzukii* were also caught in treated crops 5 out of 7 assessments.

Fewer *D. suzukii* were caught in the 2nd year of the trial (2021) compared to the 1st (2020), however it is difficult to conclude if this was due to continued precision monitoring. The annual catches between treated woodlands and their neighbouring soft fruit crops compared to untreated equivalents was not statistically significant. Other factors also influence *D. suzukii* population levels. These include winter temperatures affecting overwintering survival of adults, which were slightly lower in 2021 compared to 2020, particularly the first half of the year.

Analysis of precision monitoring trap position in 2020 found traps positioned on the woodland perimeter nearest the crop caught significantly more male *D. suzukii* than within the main woodland during summer, autumn and winter. We also found if traps were positioned amongst bramble and ivy, more *D. suzukii* were caught.

Action points for growers

- Monitor for *D. suzukii* in and around soft fruit crops year-round to predict potential incursions.
- When deploying monitoring trap placement, growers should consider *D. suzukii*'s preference for wild host species such as bramble and ivy.

Objective 3. Develop bait sprays for control of *D. suzukii*

Task 3.4_1 Determine the effect of baits in combination with reduced dose insecticides on SWD control in cherry

Headline

- In cherries, weekly alternating dilute applications of Tracer at 10 ml in 40L per ha and Exirel at 36 ml in 40L per ha, combined with Combi-protec or molasses baits, were as effective in controlling *D. suzukii* numbers (number of larvae extracted from fruit) as full field rates of the same insecticides applied at 250 ml (Tracer) or 900 ml (Exirel) in 500L per ha.
- This was a reduction in insecticide application of 96%, with the same *D. suzukii* control effect.
- Control of *D. suzukii* was equally good with the full field and new reduced Tracer rates without bait.
- If molasses bait with low insecticide rates in low volume applications are used instead of new Tracer and existing Exirel field rates in high volume applications, the savings in materials and total spray application costs are around 50%.

Background and expected deliverables

D. suzukii phagostimulatory baits could improve the efficacy of insecticides or minimise the dose of insecticide required. The use of baits is expected to improve *D. suzukii* control efficacy of insecticides with the potential to reduce application rates and improved efficacy of a wider range of insecticide types, leading to reduced risk of pesticide residues and resistance. In a series of laboratory- and field-based assays we tested commercially available and novel baits for attractiveness to *D. suzukii*, toxicity when combined with a low dose of insecticide, and finally, ability to prevent egg laying.

In 2020, small-scale replicated field trials were performed on raspberry held within insect proof mini poly tunnels. In these trials, artificial inoculations of *D. suzukii* were made and treatment efficacy was assessed on the number of *D. suzukii* larvae recovered from fruit. We found that dilute applications of Tracer at 8 ml in 40L per ha and Exirel at 36 ml in 40L per ha, combined with Combi-protec or molasses baits, were as effective in controlling *D. suzukii* numbers as full field rates of the same insecticides applied at 200 or 900 ml in 500L per ha.

Summary of the project and main conclusions

The aims of the 2021 work were to compare the efficacy of weekly alternating applications of Tracer and Exirel in cherries under semi-field conditions when used:

- at current full field rate applications
- at the new reduced rate for Tracer
- in low or reduced concentrations with and without Combi-protec or molasses.

Treatments were applied to cherry trees within a strategic orchard at NIAB EMR. Compartments were constructed to prevent treatment drift between plots. Treatments were applied from white fruit stage and efficacy was assessed on numbers of larvae and adults extracted from fruit sampled from each plot.

Weekly alternating dilute applications of Tracer at 10 ml in 40L per ha and Exirel at 36 ml in 40L per ha, combined with Combi-protec or molasses baits, were as effective in controlling *D. suzukii* numbers as full field rates of the same insecticides applied at 250 or 900 ml in 500L per ha (i.e. a reduction in insecticide application of 96% with the same *D. suzukii* control effect). Control of *D. suzukii* was equally good with the molasses and Combi-protec bait spray treatments. Control of *D. suzukii* was equally good with the full field rate and new reduced Tracer rates without bait. This new rate is expected to reflect upcoming changes in approvals for Tracer. The above treatments maintained good control of *D. suzukii* during the first three assessment weeks of the crop; by the fourth week, the majority of the fruit was over-ripe, resulting in very high level of *D. suzukii* infestation and reduced treatment efficacy.

The application time for the bait sprays was 10% of the full field rate application of insecticide sprays. Compared with untreated control plots, the dilute rates of insecticides reduced *D. suzukii* numbers by about 50%; the inclusion of baits significantly improved this control effect. *D. suzukii* numbers determined from adult emergence in boxes corresponded with larvae flotation tests, although the latter were only 30% of the former. Residues of spinosad and cyantraniliprole in fruit samples taken from the full field rate, new field rate and Combi-protec medium spray plots were below the EU MRLs. No spinosad or cyantraniliprole residues were found in any of the fruit from the bait spray + low rate treatments. Spray deposition coverage was between 5 and 134 times higher in corresponding positions for the full rate application (500 L/ha) than for the Combi-protec + low rate application (40 L/ha), except on leaves furthest from the spray nozzle at the middle tree height (both leaf surfaces) and top of trees (upper leaf surface).

If molasses bait with low insecticide rates in low volume applications are used instead of new Tracer and existing Exirel field rates in high volume applications, the savings in materials and total spray application costs are around 50%.

Action points for growers

- Adjuvants such as Combi-protec can only be used if in combination with approved plant protection products and varies from crop to crop.
- Growers should discuss the use of approved adjuvants in combination with plant protection products with their agronomy provider and adhere to approvals.

Objective 8. *Drosophila suzukii* tolerance to plant protection products

Task 8.1. Investigating the susceptibility of D. suzukii to approved plant protection products (NIAB)

Headline

- Wild strains have been tested for insecticide resistance since 2019.
- There are some differences between 2019 and 2020 in levels of susceptibility, however there is no indication that resistance has developed to the three products tested.
- In 2020, early and late season strains were established from the field in to assess differences in susceptibility.
- Generally, early season strains were more susceptible to the products tested than late season strains.

Background and expected deliverables

Since its arrival to the UK in 2012, PPP control has played a vital role in supressing *D. suzukii* numbers in vulnerable fruit crops. In 2018, an increased tolerance to spinosad was detected in Californian organic raspberries by Gress and Zalom (2018). Flies from spinosad treated areas required 4.3-7.7 times higher dose of spinosad for control than those from untreated areas.

In 2019, laboratory trials were established to identify a baseline level of susceptibility in wild populations of *D. suzukii.* Three wild populations were collected from soft and stone fruit farms in the South-East of England and mass reared in the laboratory. They were established from crops with a known insecticidal input and included two commercial crops and one with minimal inputs. These were compared an unsprayed laboratory strain, which has been in culture since 2013 and is expected to have a very low tolerance to PPP. There were varying levels of susceptibility to three PPPs (lambda-cyhalothrin (Hallmark), cyantraniliprole (Exirel) and spinosad (Tracer)) tested between the three wild populations. Although there was no detection of resistance in the populations we tested, there was an increased level of tolerance in some of the populations to one or more of the insecticides tested.

Summary of the project and main conclusions

In 2020 early season strains were collected from fruit at the end of July. Due to the logistical operations being affected by the pandemic, the early season wild strains took several months to build-up enough flies to execute the bioassays. When looking at the survival probability of the wild strains between years, there was a significant difference between 2019 and 2020 with lower survival in 2020 from all three strains when treated with spinosad and for WS1 when treated with lambda-cyhalothrin. If resistance had been developing in the field populations, we would expect 2020 to have higher survival than 2019. It may be that due to these early season populations being collected early in the growing season they have not been as exposed to insecticides as those collected towards the end of the season, like the 2019 strains.

In 2020 there were some differences in susceptibility between the early and late season strains, often with those collected earlier in the season having a lower tolerance to the PPP. This indicates that an increase in tolerance develops through the season. However, it is likely that cold winters reduce the survival of the tolerant lines as the result of a fitness cost, often associated with resistance mechanisms.

Analysis of the LC50 values from 2019-2021 has highlight some changes over time in susceptibility but to date resistance has not been detected at the three sites. In many of the interactions, the later years have a higher susceptibility than the earlier years; the opposite of what would be observed if resistance had developed.

Action points for growers

- Growers should consult their agronomist for up-to-date approvals prior to making insecticide applications.
- Where possible, growers should rotate between different modes of action to prevent insecticide resistance build-up.
- If growers suspect resistance has occurred on their farms, please alert researchers at NIAB EMR.